Front Matter [23rd International Grassland Congress Proceedings]

National Organizing Committee, International Grassland Congress

The 23rd International Grassland Congress (Sustainable use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection) took place in New Delhi, India from November 20 through November 24, 2015.

Proceedings Editors: M. M. Roy, D. R. Malaviya, V. K. Yadav, Tejveer Singh, R. P. Sah, D. Vijay, and A. Radhakrishna

Published by Range Management Society of India

23rd International Grassland Congress

Sustainable use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection

Souvenir

Published by
Range Management Society of India,
ICAR- Indian Grassland & Fodder Research Institute,
Jhansi -284003, India

Sustainable use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection

23rd International Grassland Congress

Souvenir

Editors

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Organizing Partners

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सत्यमेव जयते

D.O. No. 2482 / AM

संदेश

मुझे यह जानकर प्रसन्नता हुई है कि "चारा उत्पादन" जैव विविधता एवं पर्यावरण संरक्षण के लिए चरागाह संसाधनों का टिकाऊ उपयोग, विषय पर दिनांक 20-24 नवम्बर 2015 को "23वीं अंतर्राष्ट्रीय चरागाह कांग्रेस" का आयोजन किया जा रहा है। भारत में इस महत्वपूर्ण कांग्रेस के आयोजन की जिम्मेदारी हेतु Range Management Society of India तथा भारतीय कृषि अनुसंधान परिषद् (ICAR) के तीन संस्थानों नामतः भारतीय चरागाह एवं चारा अनुसंधान संस्थान (IGFRI), केन्द्रीय कृषि वानिकी अनुसंधान संस्थान (CAFRI), झांसी एवं केन्द्रीय शुष्क क्षेत्र अनुसंधान संस्थान (CAZRI), जोधपुर बधाई के पात्र हैं।

इस कांग्रेस का अयोजन उपयुक्त समय पर किया जा रहा है। प्राकृतिक संसाधनों पर दबाव डाले बिना खाद्य, चारा तथा पोषणिक सुरक्षा सुनिश्चित करने में हमारी प्रतिबद्धता को ध्यान में रखते हुए इसका राष्ट्रीय एवं अंतर्राष्ट्रीय स्तर पर व्यापक प्रभाव पड़ेगा। भारतीय संदर्भ में, इस कांग्रेस के माध्यम से जलवायु परिवर्तन के प्रभावों को कम करने, चारा उत्पादन बढ़ाने, पशुधन उत्पादन में गुणवत्ता बढ़ाने और मृदा स्वास्थ्य को बनाए रखकर टिकाऊ कृषि के लक्ष्य को हासिल करने की दिशा में मदद मिल सकेगी। भारत में चरागाह की उपलब्धता अलग-अलग जलवायु परिस्थितियों में 100 से 3000 मीटर की ऊंचाई पर बनी हुई है जिनमें कि शाकीय संयोजन एवं उत्पादकता में भिन्नता विद्यमान है। तथापि, सीमांत एवं भूमिहीन किसानों की आजीविका के लिए इस महत्वपूर्ण संसाधन का उचित प्रबंधन आवश्यक है।

मुझे खुशी है कि इस कांग्रेस में समग्र चरागाह एवं चारा विकास के सभी पहलुओं को शामिल किया गया है। मुझे विश्वास है कि कांग्रेस में किए जाने वाले आपसी विचार-विमर्श से किसान समुदाय के लाभ हेतु सम्यक विकास एवं मांग चालित अनुसंधान कार्यक्रमों को आगे बढ़ाने हेतु भावी दिशा विकसित करने में मदद मिलेगी।

कांग्रेस की सफलता के लिए मेरी हार्दिक शुभकामनाएं।

(राधा मोहन सिंह)

Dr. S. AYYAPPAN
SECRETARY &
DIRECTOR GENERAL

सत्यमेव जयते

DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
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Message

I am happy to learn that the three research institutes under Indian Council of Agricultural Research (ICAR) viz. Indian Grassland and Fodder Research Institute (IGFRI), Central Agroforestry Research Institute (CAFRI) and Central Arid Zone Research Institute (CAZRI) in association with International Grassland Congress (IGC) and the Range Management Society of India (RMSI) is organizing the XXIII International Grassland Congress (IGC) 2015 with the theme "Sustainable Use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection" during November 20 to 24, 2015 at New Delhi.

Grasslands, including sown pasture and rangeland, are among the largest ecosystems in the world and contribute to the livelihoods of more than 800 million people. They are a source of goods and services such as forage and food, energy and wildlife habitat, and also provide carbon and water storage and watershed protection for many major river systems. Grasslands are important for in situ conservation of genetic resources. Estimates of the proportion of the earth's land area covered by grasslands vary between 20 and 40 percent, depending on the definition.

I invite active participation of all researchers, policy makers, farmers, entrepreneurs and students in the congress, as a platform for exchanging ideas, having intense brainstorming and sharing experiences, that would aid in formulating useful policies for all perspective improvement in grassland of world.

I look forward to seeing you all at New Delhi during this mega event.

(S. Ayyappan)

Prof. M S Swaminathan
Founder Chairman

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Third Cross Street, Taramani Institutional Area
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Message

I am delighted to learn that Range Management Society of India (RMSI) in association with three research institutes under Indian Council of Agricultural Research (ICAR) will jointly organize the XXIII International Grassland Congress (IGC) 2015 on the theme "Sustainable Use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection" during November 20 to 24, 2015 at New Delhi, India.

Grasslands occupy about 26% of the world's total land area. They meet the feed and fodder requirement for livestock, maintain soil fertility, conserve soil and water resources and preserve the wildlife habitat. Grasslands, besides playing key role in sustainable production and economic outputs they do provide recreation and environmental benefits to the mankind. However, many of such grasslands are prone to degradation due to excessive grazing and changing climate scenario. Similarly a large number of forage crops are characterized by either low productivity or low quality due to substantial seasonal fluctuations. To address biotic and abiotic issues threatening the forage production, development of crops capable of adapting to harsher climate, more efficient in utilizing the resources and their integration into farming-livestock systems will ensure supply of adequate and nutritious fodder round the year. Proper understanding of the ecosystem dynamics, limiting the human intervention and facilitating synergies between crop and livestock production can prevent land degradation, can lead to more efficient use of resources and higher economic returns.

I do hope that the participants of this congress will share their views to address the issues and evolve strategic mechanisms to resolve global demand from grassland and fodder availability in future.

I congratulate and wish the organizers for a successful congress.

(M S Swaminathan)

Dr R.S. Paroda
Chairman, TAAS

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Message

I am pleased to learn that XIII International Grassland Congress on the theme "Sustainable Use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection" is being organized at New Delhi during November 20 to 24, 2015. This will be the first time that this important mega event is being organized in India

Grasslands are unique ecosystems which are important for livelihood, food, and environmental security, biodiversity conservation and maintenance of ecological balance in the nature. The importance of grasslands in the recent times has been recognized globally in restoration of ecological and environmental degradation. Accordingly, every nation is making all possible efforts for the management and conservation of these valuable natural resources. In India pasture and grasslands are degrading due to overexploitation and negligence in the management, growing animal and human populations are further aggravating the problems. Thus the theme for the congress very appropriate and I am confident that it will cover all aspects of pasture and grassland management.

I am sure that the deliberations of the congress will prove a step forward in generating a new perspective for reorientation of grassland research and development.

My best wishes for the success of the congress.

(R S Paroda)

Prof. R.B. Singh
Immediate Past President

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Message

I am glad to know that XXIII International Grassland Congress-2015 is being hosted by the Range Management Society of India in collaboration with three research institutes of the Indian Council of Agricultural Research (ICAR) during November 20-24, 2015 at New Delhi. This mega event is expected to provide a unique opportunity for Indian researchers and development organizations to share and learn from the experiences from other parts of the world.

Grasslands are multifunctional areas but their main use is grazing by livestock. Only one-sixth of the world's grasslands are on high and medium category land, hence chances of sustainable cropping seem very low. Animal production in tropical and subtropical regions is largely dependent on pastures and is prone to many problems including over-grazing, low fertility and domination by non-palatable species, if not managed properly. In context of the overall availability of fodder and quality seeds, alleviation of these concerns assumes considerable significance. While advancements in technologies should allow rapid assessment of forage availability and pasture cover, a lot more is needed to address the many environmental, sustainability, agro-ecological, and productivity constraints.

I compliment the organizers for having chosen highly relevant topics for the Congress. I am sure, the analyses and rich deliberations of the world experts will provide the way forward to an agro-ecologically and socio-economically green future.

I convey my best wishes for the success of the Congress.

(R B Singh)
Chancellor
Central Agricultural University,
Imphal

Prof. Panjab Singh
President

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Message

I am pleased to note that XXIII International Grassland Congress on "Sustainable use of grassland resources for forage production, biodiversity and environmental protection" is being organized for the first time in India during November 20-24, 2015 at New Delhi. I recall we had the first International Rangelands Congress way back in 1988 at New Delhi and now after a lapse of more than two and a half decades we have gathered experts from around the globe to discuss this important subject. Indeed, it is a great event for all of us.

Livelihood security of the farmers, especially the small, marginal and livestock herders depend on technological development and innovations. In order to attain this, the responsibility of agricultural scientists and farmers of the country has increased manifolds. Livestock constitute an integral part of the agricultural production system and is said to be the backbone of the sustainability of the system. India is now world's highest milk producing country contributing to nearly 16 percent of global milk production. This sector is also the highest contributor to India's agriculture growth and said to be responsible for providing employment and income security to millions of small and marginal farmers. Therefore, our research and development efforts are needed to promote the livestock sector and make provisioning for adequate nutritious and healthy feed and fodder for sustaining their productivity. Grasslands and rangelands offer vast opportunities to let this actualize. We are also aware that tropical grasslands are under great threat for several reasons including much talked about climate change and, therefore, it needs our special attention.

I hope the deliberations during the congress will focus on these issues and offer valuable scientific solutions.

My very best wishes for the success of the congress.

(Panjab Singh)

Dr Gurubachan Singh
Chairman

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Message

I am glad to know that International Grassland Congress (IGC) in association with the Range Management Society of India (RMSI) and Indian Council of Agricultural Research (ICAR) will jointly organize XXIII International Grassland Congress-2015 during November 20 to 24, 2015 at New Delhi, India.

Grasslands are remarkable ecosystems providing ecological infrastructure, economic and social benefits necessary to support life areas, but their main use is for grazing livestock. In all but the coldest and driest zones, large areas of the better land have been cleared for crops and subsistence farming in traditional areas. Only one-sixth of the world's grasslands fall in the high and medium productivity category hence, chances of sustainable cropping seems low. Grassland productivity is relatively high but prone to temporal variability and may cause feed gaps. Animal production in tropical and subtropical regions is largely dependent on pastures and it has always high demand of adaptive, productive lines with nutritious quality fodder. Concern on these aspects should also be made along with the availability of fodder and seeds. Advancement in technologies allow relatively rapid assessment of forage availability and pasture cover. But, still the many issues on environmental and productive constraints needs to be addressed.

I compliment the organizers for choosing the relevant topic for the congress. I am also happy to note that in this congress experts will be deliberating on the scope of improvement over the past achievements.

I convey my best wishes for the success of the congress.

(Gurubachan Singh)

Dr J.S. Sandhu
Deputy Director General
(Crop Science)

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Krishi Bhawan
Dr Rajendra Prasad Road, New Delhi-110001

Message

It is indeed, heartening to note that XXIII International Grassland Congress on "Sustainable use of grassland resources for forage production, biodiversity and environmental protection" is being organized during November 20 -24, 2015 at New Delhi. I welcome all the delegates to the congress and hope that congress will provide new directions for the research and development in the area of grassland and pasture land improvement and management.

The total area of permanent pastures and grasslands in India about 12.4 M ha or 3.9% of the country`s geographical area. An area of 15.6 M ha, classified as waste land, is also used for grazing. Forests, and their associated grasslands and fodder trees, are another major source of grazing and fodder collection. Arable agriculture contributes a major fodder resource in the form of crop residues for feeding to the animals during drier period. There are pressures on such resources on account of increased livestock load and lack of regulatory mechanisms. However, there is great scope of development of grazing areas and fodder cultivation for the fast growing livestock sector, including dairy.

I am sure that deliberations during this congress will provide an opportunity to discover the ways and means for achieving the future goal in related areas.

My best wishes for the success of Congress.

(JS Sandhu)

From Chairman's Desk

The first International Grassland Congress (IGC) was held at Leipzig, Germany during May 20-31, 1927 and the participants were only 16 scientists from 7 European countries viz. Austria, Denmark, Finland, Germany, Norway, Sweden and Switzerland. They assembled in Bremen and made a study tour through north-west Germany, visiting Emden, Berlin and Dortmund and finally arrived at Leipzig, where there were two days of scientific discussion on different aspects of grasslands. Since then IGC is promoting interchange of information among the participated counties on all aspects of natural and cultivated grasslands and forage crops for the benefit of mankind, including sustained development, food production and the maintenance of biodiversity. During its memorable and remarkable journey over the years (1927-2013), the IGC Committee has organized 22 numbers of congresses. These twenty-two International Grassland Congresses were held in every continent except Africa, and researchers/scientists from North America, Western Europe and Australia and New Zealand dominated the proceedings. In the series, we are organizing 23rd IGC, first time in India. Earlier in 1977, Prof. S.C. Pandeya, a renowned ecologist and then outgoing chairman of the Continuing Committee, was expected to host the XIV Congress at New Delhi, India, but his proposition could not be materialized. The XIV Congress was hosted by the American Forage and Grassland Council, at Lexington, Kentucky, USA, in 1981.

Now that dream of Prof. S.C. Pandeya has been realized and we are hosting 23rd IGC at New Delhi as a third Asian country after Japan (1985) and China (2008). The main theme of the Congress is '***Sustainable use of grassland resources for forage production, biodiversity and environmental protection***' with five sub themes *viz*.-

- Grassland resources
- Grassland production and utilization
- Sustainability of grassland–social and policy issues
- Biodiversity conservation & genetic improvement of range and forage species
- Environmental issues related to grassland

Scientific programme includes plenary (7) and concurrent sessions (30), pre-congress workshops (3) and forums (2). We have received more than 700 abstracts from 55 different countries and expected to have a large gathering. The congress will provide a forum for scientists, agricultural engineers and researchers in the fields of grassland improvement, plant physiology, plant ecology, environmental science, grazing management, livestock production etc., to come together to exchange ideas and views. Our National Agricultural Research System (NARS) will also get a rare opportunity to showcase its grassland environments, R&D and technologies to an international audience. In fact, the grassland and rangeland resources are extremely important in India as it has different of types of rangelands from alpine pastures in the high Himalayas to arid pastures in western and rainfed pastures in south India. In India more than 40% of the huge livestock population (over 500 million heads) still depends upon grazing in the rangelands/ pastures (on high altitudes), desert areas and rainfed farming systems on two third area of the crop lands, which includes around 85 m ha of area. The subcontinent has five major types of grass covers. These are: (1) *Sehima-Dichanthium* spread in peninsular India (dry sub-humid zone except Nilgiri). The floristic list includes 24 perennial grasses and 129 other herbaceous species including 56 legumes. (2) *Dichanthium-Cenchrus-Lasiurus* cover of semi-arid extends to northern portion Indian of Gujrat, Rajasthan, western Uttar Pradesh, Delhi and Punjab. 11 grasses and 45 other herbs reported from these covers. (3) *Phragmatis-Saccharum-Imperata* cover spread in moist sub-humid zone of Ganga alluvial plain in north India. About19 grass and 56 herbs are reported from these grass covers. (4) *Themeda-Arundinella* cover extends to humid mountain regions and moist sub-humid areas of Assam, Manipur, West Bengal, Uttar Pradesh, Punjab, Himachal Pradesh, Jammu and Kashmir. (5) *Temperate and alpine* cover which spreads over the temperate and cold desert areas. of Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, West Bengal and the north-eastern states. There are 47 perennial grasses, 5 annual grasses and 68 dicots, including 6 legumes.

These grasslands play a major role in the economy of the country as these are used as pastures/forage resources for domestic grazing animals which provide milk, meat and draft power. Today India is the highest producer of milk (producing more than 140 million tonnes per annum) in the world and it has been observed

that milk is the primary source of protein in large vegetarian based Indian population. They are also associated with livelihoods of thousands of people as grasses are used as fuel, shelter and various traditional activities. The estimates of grasslands and shrub lands in India vary from 3.7% to as much as 12% of the total area. Based on a conservative estimate, out of 301 m ha total utilizable area, 51% is devoted to arable lands, 16% to forests, 4% to permanent pastures and remaining 29% to other grazing lands and uncultivable degraded lands.

India needs an appropriate national policy on 'Grasslands and grazing management'. Earlier reviewing National Forest Policy (1988), Mr. C. D. Pandya, IGF (Retd.) and then Chairman of the Expert Review Committee also recommended that a national grazing policy should come into effect without delay. The policy which should address issues pertaining to diversion of grazing lands for other purposes, conversion of critical grassland habitats into plantations, research on grassland ecology and pasture management, capacity building of managers and resource users, rehabilitation of degraded grazing lands, collaborative management of grazing lands and forage resources with local communities. The Policy should also look into the issues related to transport of forage from one area to another, migration of livestock from one area/state to another, practicing rotational grazing and stall feeding of animals, regulating the number of livestock, and the problems of stray and feral cattle etc. The areas under natural grasslands/pastures/ common property resources are on decline, however, in some of the regions especially under arid ecosystem, theses resources are still of great importance to livestock farmers. Excessive stocking pressure and degeneration of the original pasture grasses has led in to decline in biomass productivity from these resources. A comprehensive strategy for rejuvenation of these important resources is also required like encouraging establishment of cooperatives for grasslands and pasture management. Such cooperatives should be formed on the lines of highly successful Indian milk-cooperatives.

Perspectives and perceptions regarding the most appropriate roles and functions of grasslands have been changed during the recent past. There are numerous regional, national and global issues with which utilization of grasslands are related. These include the function of grasslands to provide social and cultural needs for many rural societies, their role in reducing greenhouse gas (GHG) emissions, as water catchments, and the preservation of ecosystem biodiversity. At the same time increased global demand for food must be met without much harm to these resources. Since grasslands are of such major global importance, they need to be better managed in order to best fulfil those functions. But knowledge is often lacking, particularly for tropical grasslands including Indian grasslands. The knowledge that is available from the much more extensive studies of temperate grasslands often cannot be directly applied to tropical grasslands. Developing appropriate management strategies for tropical grasslands is challenging, keeping in view the diversity of agro-ecological systems/regions, the animal production constraints and soil–plant–animal interactions. Appropriate management strategies for defined production, environmental and social targets will generally include inventories and assessments of the grasslands and grazing animals available and knowledge of the important herbage–animal relationships. A number of technological developments have been reported globally, which provide, or have the potential to provide solutions towards improved measurement, monitoring and management of grassland resources and sustained developments.

I wish to thank IGC Continuing Committee for hosting 23rd International Grassland Congress at New Delhi, the historical city and capital of incredible India. I also wish to thank Department of Agricultural Research and Education/ Indian Council of Agricultural Research, Ministry of Agriculture, Ministry of Home and Ministry of External Affairs, Government of India, New Delhi for coming forward to prop up this International event. The organization of this congress could be possible because of incessant supports of honourable Sh. Radha Mohan Singhji, Patron and Minister of Agriculture, Dr. Sanjeev Kumar Balyanji, MOS (Agriculture & FPI) and Sh. Mohanbhai Kundariyaji, MOS (Agri. & FPI). The constant support provided by Dr. S. Ayyappan (Secretary, DARE & Director General, ICAR), both Former and Present Deputy Director General (Crop Science), other Deputy Director Generals (ICAR), Assistant Director Generals (ICAR), New Delhi, Vice Chancellors from SAUs and Directors from different institutes in organizing this congress is gratefully acknowledged. The guidance and supports from our nobles like Prof. (Dr.) M.S. Swaminathan, R.S. Paroda, R.B. Singh, Panjab Singh, Gurbachan Singh and others are duly acknowledged. Thanks are due to all the Chairpersons, Co-Chairpersons, Members, Experts on grasslands & fodders and renowned Speakers of different technical and plenary sessions for their whole hearted supports.

I acknowledge the financial support of different Organizations/Institutes, Private Agencies and Firms through sponsorships and advertisements. I also gratefully acknowledge the efforts and untiring supports of different Organizing Secretaries, Committees, Staffs of IGFRI and CAFRI, Jhansi, besides supports from CAZRI, Jodhpur and NIANP, Bangalore in organizing the congress. I acknowledge the professional services rendered by the KW Conferences Pvt Ltd. Last but not the least, I am also thankful to all the delegates, who have come from different parts the globe for making this event possible and successful.

I hope that this 23rd IGC will bring together all those innovative technologies from different corners of the globe and allow the scientific community to discuss various advances made in the field of grassland management and development, which in turn will benefit the mankind.

P. K. Ghosh
Chair, National Organizing Committee, IGC 2015
Member, IGC (South-East Asia)
President. Range Management Society of India &
Director,
ICAR-Indian Grassland & Fodder Research Institute,
Jhansi, India

ABOUT ORGANIZERS

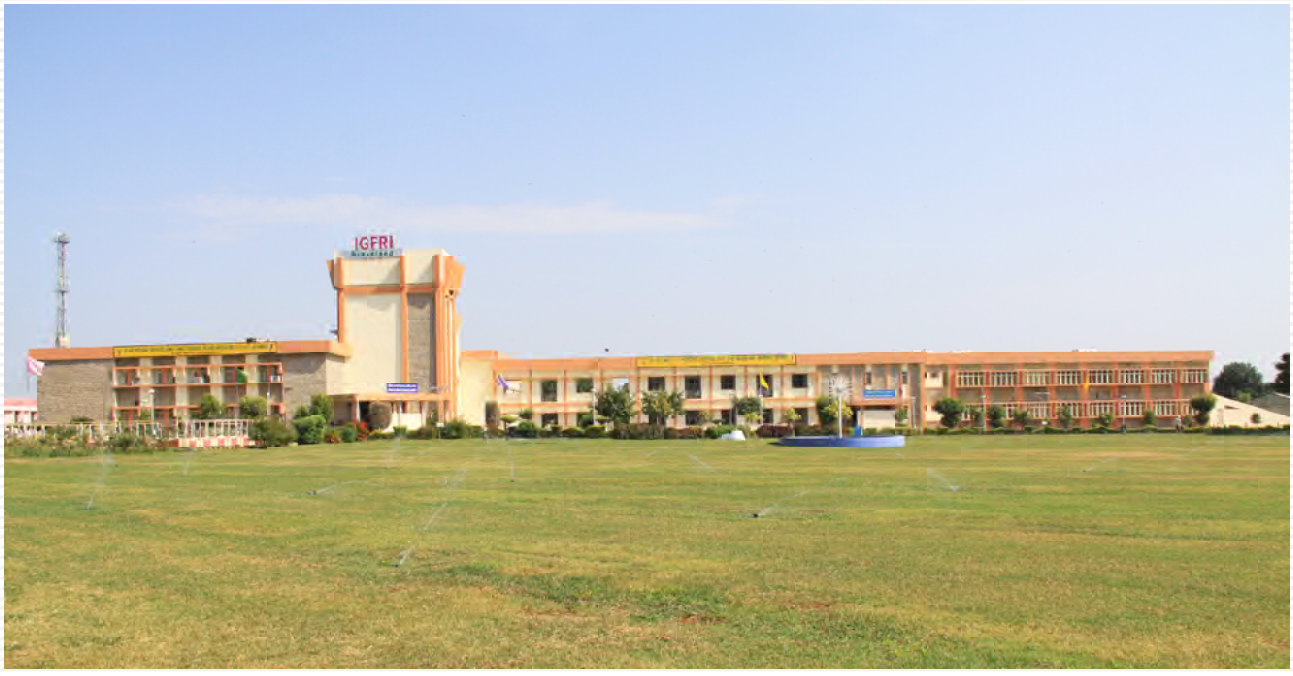
The Range Management Society of India

The **Range Management Society of India** (RMSI) was founded in 1978 to promote client-oriented ecologically sustainable range and forage husbandry with economic productivity and to support excellence in scientific research in agriculture with focus on grassland and fodder resources, agroforestry, plant-animal inter-relationships, environment, dairy industry and allied sciences. One of the major objectives of the Society is to provide national and global platform to the scientists, development workers, practitioners, planners and policy makers, industrialists, financial managers and donors related to grassland and fodder resources development for exchange of ideas for the benefit of the humanity. The Society has organized several workshops, seminars, symposia and conferences in the past, in addition to the III International Rangeland Congress in 1988 and International Conference on Agroforestry for the Asia-Pacific region in 1994.

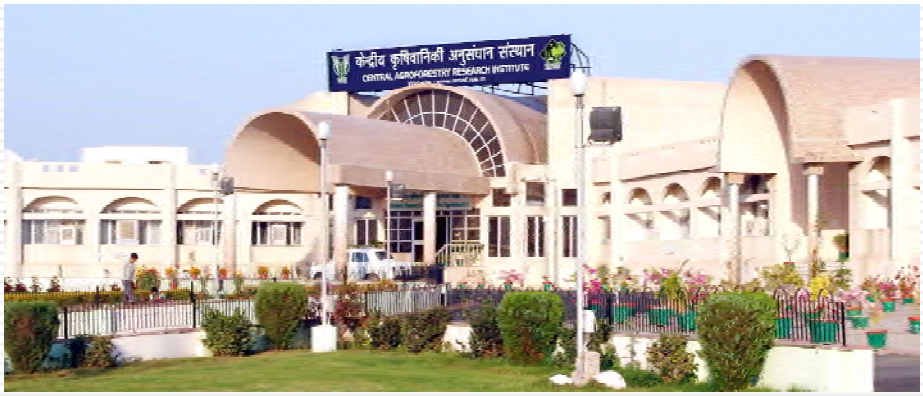
The present congress is intended to involve a wide range of experts to come out with concrete recommendations, based on their research, experience and discussions during the meeting, regarding the present grassland and forage resource to meet the increasing demand of livestock products and challenges faced in climate The present congress is intended to involve a wide range of experts to come out with concrete recommendations, based on their research, experience and discussions during the meeting, regarding the present grassland and forage resource to meet the increasing demand of livestock products and challenges faced in climate

ICAR-Indian Grassland and Fodder Research Institute

ICAR-Indian Grassland and Fodder Research Institute, a national Institute under the administrative control of Indian Council of Agricultural Research, is mandated to conduct basic, strategic, applied and adaptive research; development and training in forage production and its utilization. The Institute has highly experienced and internationally trained human resources engaged in need-led, participatory, inter-disciplinary approaches. With more than 50 years of experience in forage research and development, IGFRI today stands as the premier R&D institution in South Asia for sustainable agriculture through quality forage production for improved animal productivity.



ICAR - Central Agroforestry Research Institute



CAFRI was established at Jhansi on 8th May, 1988 under the aegis of Indian Council of Agricultural Research, New Delhi to cater to basic, strategic and applied research needs in the field of agroforestry. CAFRI in its short tenure has developed several agroforestry systems that have gone to farmer's field and provided livelihood support to poor farmers. CAFRI is recognized worldwide for its research and development capabilities, agroforestry database & information repository and natural resource management on watershed basis. The centre conducts basic and strategic research System Research, Natural Resource and Environment Management, Tree Improvement, Post-Harvest & Value Addition, HRD, Technology Transfer & Refinement programme.

ICAR - Central Arid Zone Research Institute

Central Arid Zone Research Institute is a premier organisation of the Indian Council of Agricultural Research (ICAR) with the distinction of being one of the first institutes of its kind in the world devoted to arid zone research and development. During the last five decades of its existence, CAZRI has carried out systematic research on understanding and managing the region's natural resources, sustainable farming systems, improvement in plant resources, especially the crop plants, livestock production and management and use of alternate energy resources. Several need-based, cost effective technologies like sand dune stabilization, wind erosion control, water management, grassland improvement, watershed development, rehabilitation of wastelands, arid land farming, arid horticulture, alternate land use strategies, pest management, solar devices, etc. have been developed and transferred to farmers and other stakeholders.